8015

Geology 202
Igneous and Metamorphic Petrology

Department of Applied Geology
Western Australian School of Mines
Faculty of Science and Engineering

UNIT OUTLINE

Semester 2 2008
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INTRODUCTION

Welcome to Geology 202 – Igneous and Metamorphic Petrology. The aim of this unit is to provide students with an understanding of the variation in nature and composition of igneous and metamorphic rocks, and how the character of each rock may be used as evidence of the location and geological environment of formation within the Earth. On completion of the unit, you will be able to classify both igneous and metamorphic rock types, and will have a significant understanding of the magmatic and metamorphic processes occurring within the Earth.

The pre-requisite for Geology 202 is Geology 201 (which provides an introduction to minerals and use of the petrological microscope) and indirectly Geology 102 (which provides an introduction to igneous and metamorphic rocks). Although not a co-requisite, Geology 214 links closely with Geology 202 and students are encouraged, whenever possible, to study these in parallel. Geology 214 gives much time to the application of igneous phase diagrams and chemical variation diagrams in studies of magma genesis, with lesser time on metamorphic phase diagrams. Completion of Geology 202 is itself a pre-requisite for Geology 301 and 316, third year units that consider the evolution of igneous and metamorphic rocks on a regional scale.

ESSENTIAL ADMINISTRATIVE INFORMATION

<table>
<thead>
<tr>
<th>Unit Title</th>
<th>Geology 202 – Igneous and Metamorphic Petrology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Study Package Number</td>
<td>8015</td>
</tr>
<tr>
<td>Unit Coordinator</td>
<td>A/Prof Ron Watkins</td>
</tr>
<tr>
<td>Teaching Area</td>
<td>Department of Applied Geology</td>
</tr>
<tr>
<td>Credit Value</td>
<td>25</td>
</tr>
<tr>
<td>Mode(s) of study</td>
<td>Internal</td>
</tr>
<tr>
<td>Co-, Pre- and Anti-requisites</td>
<td>Unit 9771 Geology 201 – Mineralogy is a pre-requisite for this unit. Unit 10195 Geology 244 – Petrology and Geochemistry is an anti-requisite.</td>
</tr>
<tr>
<td>Additional requirements</td>
<td>None</td>
</tr>
<tr>
<td>Core Unit status</td>
<td>This is a core unit in the BSc (Applied Geology) and you may be terminated from this course of study if you fail it twice.</td>
</tr>
<tr>
<td>Result Type</td>
<td>Grade/Mark</td>
</tr>
<tr>
<td>Ancillary Fees and Charges</td>
<td>This unit has no ancillary fees or charges.</td>
</tr>
<tr>
<td>Unit Website</td>
<td>Unit materials can be accessed from the associated Web-CT site via <a href="http://oasis.curtin.edu.au">http://oasis.curtin.edu.au</a></td>
</tr>
<tr>
<td>Faculty or School Website</td>
<td><a href="http://www.geology.curtin.edu.au">www.geology.curtin.edu.au</a></td>
</tr>
<tr>
<td>Tuition Pattern</td>
<td>Lecture 1 (1 hour): Monday 13.00–14.00 Rm. 307.101 Lecture 2 (2 hour): Thursday 08.00–10.00 Rm. 105.107 Practical (2 hour): either Friday 08.00–10.00 Rm. 312.202 or Friday 12.00–14.00 Rm. 312.202</td>
</tr>
<tr>
<td>Study Load</td>
<td>Students are expected to spend an average of five hours per week on background reading and completing practical exercises in addition to the five hours of contact teaching.</td>
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</table>
TEACHING STAFF

The lecturers for this unit and their contact details are below:

<table>
<thead>
<tr>
<th>Lecturer:</th>
<th>A/Prof Ron Watkins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email:</td>
<td><a href="mailto:R.Watkins@curtin.edu.au">R.Watkins@curtin.edu.au</a></td>
</tr>
<tr>
<td>Phone:</td>
<td>(08) 9266 3577 or 7824 or 4326</td>
</tr>
<tr>
<td>Fax:</td>
<td>(08) 9266 3153</td>
</tr>
<tr>
<td>Building &amp; Room:</td>
<td>610-116a and 312-214</td>
</tr>
</tbody>
</table>

Contact Hours:

<table>
<thead>
<tr>
<th>Lecturer:</th>
<th>A/Prof Ian Fitzsimons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email:</td>
<td><a href="mailto:I.Fitzsimons@curtin.edu.au">I.Fitzsimons@curtin.edu.au</a></td>
</tr>
<tr>
<td>Phone:</td>
<td>(08) 9266 7968</td>
</tr>
<tr>
<td>Fax:</td>
<td>(08) 9266 3153</td>
</tr>
<tr>
<td>Building &amp; Room:</td>
<td>312-217</td>
</tr>
</tbody>
</table>

Contact Hours: Ian is often busy as Head of Geology. Please make an appointment with the Geology Office if you need to see him.

The teaching staff will assist you with your learning and any problems or difficulties you may be experiencing while undertaking this unit. They will also mark your assignments and provide feedback in relation to your progress in this unit.

If you leave a message for a lecturer on email or telephone they will try to respond as soon as possible, but please allow for a response time of up to 5 working days.

UNIT COORDINATOR

Every unit also has a person who is responsible for the overall administration of that unit. This person is the Unit Coordinator. If you cannot contact the person who is teaching you at the time or if you have general administrative queries about this unit, you may wish to contact the Unit Coordinator for this unit.

<table>
<thead>
<tr>
<th>Coordinator:</th>
<th>A/Prof Ron Watkins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email:</td>
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</tr>
<tr>
<td>Building &amp; Room:</td>
<td>610-116a and 312-214</td>
</tr>
</tbody>
</table>

Contact Hours:
UNIT SYLLABUS


LEARNING OUTCOMES

On successful completion of this unit you will be able to:

1. Describe igneous and metamorphic rocks in thin section, using accurate and concise terminology, and categorize them using internationally accepted classification schemes
2. Infer the source regions and modes of formation of common magma types
3. Explain the wide variety of igneous rock compositions found at the Earth's surface in terms of magma differentiation
4. Infer original rock types, metamorphic conditions and deformational histories from minerals and fabrics observed in metamorphic rocks
5. Explain the development of metamorphic minerals and fabrics in terms of chemical equilibrium, and the processes of nucleation, mineral growth and recrystallization

LEARNING ACTIVITIES

This unit involves the following learning activities:

During weeks 1 - 7, the Monday lecture will be devoted to igneous petrography - the description and classification of igneous rocks. In weeks 8 - 14, metamorphic petrography and specific metamorphic rock types will be discussed.

During weeks 1 - 7, Thursday’s lecture is devoted to igneous petrogenesis - how igneous rocks are formed, and in weeks 8 - 14, the formation of metamorphic rocks is discussed.

The two-hour practical classes comprise a number of exercises that complement and reinforce material presented in lectures and allow students to develop the skills needed to describe and interpret igneous and metamorphic rocks in thin section.

STUDENT FEEDBACK

We welcome your feedback as one way to keep improving this unit. Later this semester, you will be encouraged to give unit feedback through eVALUate, Curtin’s online student feedback system (see http://evaluate.curtin.edu.au). Recent changes to this unit in response to student feedback through eVALUate include the refurbishment of the microscope laboratory with 24 new petrographic teaching microscopes.

For Semester 1 and Semester 2 eVALUate is open for student feedback in weeks 12-17.

For other study periods see http://evaluate.curtin.edu.au/info/dates.cfm
LEARNING RESOURCES

The following resources will be posted on the Web-CT site for this unit:

1. Copy of this unit outline
2. Lecture material in the form of PowerPoint presentations and/or text files
3. Other useful material

If you are unable to access the Web-CT site for this unit please contact the Unit Coordinator.

TEXT BOOKS

Essential Texts:
There are no textbooks that you need to purchase in order to complete this unit.

Recommended Texts:
No readily available textbook mirrors precisely the scope of the Igneous Petrology component of the unit. Magmas and Magmatic Rocks by E.A.K. Middlemost (Longman) is appropriate but is now out of print. Igneous Petrology by A. Hall (Longman Scientific & Technical) is a good, rather more advanced, text that would also be useful for 3rd Year studies. It, too, has recently gone out of print. Copies of both these textbooks are to be found in the Closed Reserve section of the Library. Other useful reference texts include Igneous Petrology by Hughes, and Igneous Petrogenesis: A Global Tectonic Approach by Wilson. The Atlas of igneous rocks and their textures by W.S. MacKenzie, C.H. Donaldson and C. Guilford is a useful guide to recognising igneous textures.

The most suitable textbook for the Metamorphic Petrology component is An Introduction to Metamorphic Petrology by Yardley B.W.D (Longman, 1989), which has also recently gone out print! This, and a range of other undergraduate metamorphic texts are available in the library and all provide useful perspectives on the material covered in lectures. The Atlas of Metamorphic Rocks and their Textures by Yardley B.W.D., MacKenzie W.S. & Guilford C. (Longman, 1990) contains a large number of colour photomicrographs illustrating important metamorphic minerals and fabrics, and is a useful reference for study of metamorphic rocks in thin section.

It is essential that each student has access to a standard optical mineralogy textbook to assist with mineral identification. An Introduction to Rock Forming Minerals by Deer,W.A., Howie, R.A. and Zussman, J. (Longman) is most commonly purchased, but alternatives include Optical Mineralogy by P.F. Kerr (McGraw Hill) and An Introduction to Mineralogy by W.D. Nesse (Oxford). In addition, many students find useful Elsevier's Mineral and Rock Table. The Atlas of rock-forming minerals in thin section by W.S. MacKenzie and C. Guilford may be useful but is not a substitute for a standard optical mineralogy textbook.

ASSESSMENT DETAILS

Assessment Summary

<table>
<thead>
<tr>
<th>Assessment Tasks</th>
<th>Worth</th>
<th>Due</th>
<th>Unit Learning Outcome Assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical Assignments and Tests</td>
<td>30%</td>
<td>During semester</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td>Practical Exams</td>
<td>30%</td>
<td>Weeks 8 and 14</td>
<td>1, 2, 4</td>
</tr>
<tr>
<td>Theory Exam</td>
<td>40%</td>
<td>Exam Period</td>
<td>2, 3, 4, 5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100%</td>
<td></td>
<td></td>
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</table>
Assessment 1 – Practical Assignments and Tests

Worth: 30%
These exercises are designed to provide training and feedback in rock description and interpretation ready for the practical exams to be held later in semester.

(1) An **Igneous Assignment** (10%) will be given out during Week 2, to be undertaken during the remainder of the igneous section as relevant experience is gained. This must be submitted by 17.00 hr on Friday 26th September.

(2) An **Igneous Practical Test** (5%) will be held during Week 7, at the conclusion of the igneous practical classes, and in preparation for the practical exam.

(3) The first three metamorphic practical sessions involve the completion of Five Metamorphic Thin Section Descriptions (10%). TWO descriptions should be submitted by 5pm Friday 26 September, and will be marked and returned to students to provide feedback before the submission deadline for the final THREE descriptions at 5pm Friday 17 October.

(4) The practical session in Week 12 will involve Metamorphic Fabric Interpretation (5%), and the completion of an exercise to be submitted by 5pm Friday 23 October to allow time for feedback prior to the metamorphic practical exam.

**Assessment 1 Marking Criteria**
To be graded highly in the practical assignments and tests you will need to:

1. Identify the major minerals present in igneous and metamorphic rock samples
2. Describe and illustrate textures and fabrics in igneous and metamorphic rock samples
3. Infer the cooling history of igneous rock samples
4. Infer the parent rock and metamorphic grade of metamorphic rock samples
5. Give igneous and metamorphic rock samples an appropriate name

Assessment 2 – Practical Exams

Worth: 30% (15% for the igneous exam and 15% for the metamorphic exam)

**Held: Time to be arranged (Igneous Exam) and Week 14 (Metamorphic Exam)**
The duration of each practical exam will be 2 hours, and each will involve describing a small number of rock samples in hand specimen and thin section using the procedures outlined in the practical sessions.

**Assignment 2 Marking Criteria**
To score highly in the practical exam you will need to:

1. Identify the major minerals present in igneous and metamorphic rock samples
2. Describe and illustrate textures and fabrics in igneous and metamorphic rock samples
3. Infer the cooling history of igneous rock samples
4. Infer the parent rock and metamorphic grade of metamorphic rock samples
5. Give igneous and metamorphic rock samples an appropriate name
Assessment 3 – Theory Exam

**Worth: 40%**

_Held: Examination period (time and date to be published in the Examination timetable)_

The duration of the theory exam is 2 hours, and it comprises two sections of equal value. In each section you will be asked to answer two questions.

Section A is concerned with igneous petrology.

Section B is concerned with metamorphic petrology.

You will be given information on the format of the exam paper during the final lecture of the unit.


**Assignment 3 Marking Criteria**

To score highly in the theory exam you will need to:

1. Provide factually correct answers to the questions
2. Present arguments in a logical fashion
3. Provide illustrations where appropriate

**Referencing Style**

Students should use the Chicago author-date referencing style when preparing assignments. More information can be found on this style from the Library website: [http://library.curtin.edu.au/referencing/index.html](http://library.curtin.edu.au/referencing/index.html).

**Guidelines for Submission:**

All assignments must be accompanied by an Assignment Cover Sheet.

All assignments must be received by the due date.

Marks will be lost for late submission of assignments at a rate of 5% per day, except where an extension is negotiated prior to the assessment due date or where unforeseen medical, family or other issues prevent timely submission. Extensions will usually require supporting documentation.

**Assignment Marking**

Students should allow a 2 week marking turn-around for written assignments.
STUDENTS’ RIGHTS AND RESPONSIBILITIES

It is the responsibility of every student to be aware of all relevant legislation, policies and procedures relating to their rights and responsibilities as a student. These include:

- the Student Charter,
- the University’s Guiding Ethical Principles,
- the University’s policy and statements on plagiarism and academic integrity,
- copyright principles and responsibilities,
- the University’s policies on appropriate use of software and computer facilities,
- students’ responsibility to check enrolment,
- deadlines, appeals, and grievance resolution,
- student feedback,
- other policies and procedures
- electronic communication with students

See www.students.curtin.edu.au/administration/responsibilities.cfm for comprehensive information on all of the above.

ADDITIONAL INFORMATION

Deferred and Supplementary Assessment

You might be granted a deferred assessment for this unit if you are unable to complete an assessment task due to documented circumstances outside of your control, or a supplementary assessment when your final grade from the unit is between 45 and 50 and your academic record and personal circumstance warrant a second chance to pass the unit.

Deferred and supplementary exams will be held in Orientation Week of Semester One 2009 to accommodate the high number of student with vacation work. Students expecting to complete their degree this semester will have the opportunity to take any supplementary or deferred exams earlier to allow them to meet deadlines for graduation.

Enrolment and HECS

It is your responsibility to ensure that your enrolment is correct - you can check your enrolment through the eStudent option on OASIS, www.oasis.curtin.edu.au, and you can also print off an Enrolment Advice.

You can make requests to have corrections made to your Semester One enrolment up to 31 August. The University will not change records after 31 August. HECS liabilities (where they apply) and your results depend on your 31 August enrolment. Withdrawals made after that date will not reduce your HECS liability.
<table>
<thead>
<tr>
<th>WEEK</th>
<th>DATES</th>
<th>TOPIC (L = lecture, P = practical):</th>
<th>STAFF</th>
<th>ASSESSMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Mon 4 Aug Thu 7 Aug Fri 8 Aug</td>
<td>L1: Igneous classification; mineralogical classification  L2: Magma source rocks  L3: Primary magmas</td>
<td>RTW RTW RTW</td>
<td></td>
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<tr>
<td>5.</td>
<td>25-29 Aug</td>
<td>Tuition Free Week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Mon 8 Sep Thu 11 Sep Fri 12 Sep</td>
<td>L1: Nature of granite and magmatic intrusion  L2: Thermo-chemical and -gravitational differentiation  L3: Liquid immiscibility</td>
<td>RTW RTW RTW</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Mon 8 Sep Thu 11 Sep Fri 12 Sep</td>
<td>L1: Igneous textures (revision)  L2: Wall-rock assimilation  L3: Magma mixing</td>
<td>RTW RTW RTW</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Mon 15 Sep Thu 18 Sep Fri 19 Sep</td>
<td>L1: Metamorphic minerals in thin section  L2: Metamorphism and metamorphic grade  P: Thin section description of metamorphic rocks</td>
<td>ICWF ICWF ICWF</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Mon 22 Sep Thu 25 Sep Fri 26 Sep</td>
<td>L1: Classification of metamorphic rocks  L2: Nucleation, growth and equilibrium  P: Thin section description of metamorphic rocks</td>
<td>ICWF ICWF ICWF</td>
<td>Hand in TWO metamorphic thin section descriptions</td>
</tr>
<tr>
<td>10.</td>
<td>29 Sep 3 Oct</td>
<td>Tuition Free Week (Geology 292 Field Trip)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Mon 13 Oct Thu 16 Oct Fri 17 Oct</td>
<td>L1: Contact metamorphism  L2: Regional metamorphism: metabelites  P: Metamorphic fabrics in thin section</td>
<td>ICWF ICWF ICWF</td>
<td>Hand in THREE metamorphic thin section descriptions</td>
</tr>
<tr>
<td>15.</td>
<td>3-7 Nov</td>
<td>Study Week</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>10-14 Nov</td>
<td>Examinations</td>
<td></td>
<td>Theory Exam</td>
</tr>
<tr>
<td>17.</td>
<td>17-21 Nov</td>
<td>Examinations</td>
<td></td>
<td>Theory Exam</td>
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